

On the Generalization of the Boserup Model: Some Clarifications

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In a recent issue of this journal W. C. Robinson and W. A. Schutjer attempted a generalization of the model of agricultural intensification put forward by Ester Boserup in her classic book, *The Conditions of Agricultural Growth*.¹ They criticized my interpretation of her model on the grounds of its description of land-use technology.² The basic point in dispute is whether Boserup's notion of intensification of land use is technical change or technical progress. They maintain that I have unnecessarily restricted the interpretation of intensification to technical change and that it is better understood as technical progress. Since this issue goes to the heart of Boserup's contribution I would like to show that it can be easily established from her own writing that it is technical change that she had in mind and, more important, that the technical progress interpretation put forth by Robinson and Schutjer is inconsistent with her model since it precludes a systematic role for population as a *condition* of agricultural growth.

Boserup's model attempts to show that in subsistence environments population growth is a necessary condition for changes from less to more intensive techniques of land use, such as changes from forest to bush fallow to permanent cropping. The role of population growth as a determinant of land-use intensity is based on the assumption that output per man-hour declines as more intensive techniques are adopted. In other words, intensive techniques are less desirable in and of themselves, and population growth is necessary to make their adoption rational. Since this assumption is at the heart of Boserup's model, it is important to establish her position on it. Speaking of forest versus short fallow, she writes, "I am convinced that the former one usually requires less hard human labour than the latter,"³ and "It may be sound economic reasoning rather than indolence which induces a community of cultivators under the system of long fallow to refuse to

abandon fire and axe, when they are offered help to change to plough culture, and instead move to another place in the forest.”⁴ She also says, “Peasants with too little land for cultivation with short fallow and with no other employment opportunities behave rationally when they use the water from irrigation canals and change to more intensive cultivation, but peasants with land enough for short-fallow cultivation may be equally justified in finding that the addition to output which can be obtained by watering the crop is an insufficient reward for the reduction of the customary seasonal leisure.”⁵ Finally, comparing irrigated and dry-farmed cultivation, she writes, “Higher yields per crop hectare are obtained by a much higher labour input per crop hectare.”⁶ Robinson and Schutjer also seem to agree on this point when they say, “Boserup herself argues for the falling average productivity interpretation.”⁷

However, Robinson and Schutjer argue that the assumption of lower labor productivity in more intensive techniques is not necessary for the Boserup model to work. Speaking of Boserup’s notion of technical change, they advance the technical progress interpretation of intensification: “Genuine technological change permits more output from the same inputs. Boserup makes clear that this is her definition.”⁸ But they do not refer the reader to any place where she does this.⁹ In short, Robinson and Schutjer seem to believe that the role of population as the cause of intensification is consistent with the notion that intensification is technical progress. I believe this proposition is untenable.

In order to clarify the discussion let us refer to the diagram that I originally employed to explain Boserup’s argument, and which Robinson and Schutjer also reproduced in their paper (see fig. 1). The main advantage of this diagram is that it clears up the confusion that appears in Boserup’s own discussion regarding average and marginal products of labor. The isoquants depict a given level of (subsistence) output produced by a representative cultivator with various combinations of land and labor per person for two techniques, which for ease of reference I will call shifting cultivation and permanent cropping. To keep the diagram simple, let us assume constant returns to scale so that things do not change as population and, hence, the scale of production increases. The relative positions of the isoquants reflect Boserup’s notion of declining average labor productivity as we move from the less to the more intensive technique. Note, however, that factor proportions can change within each technique according to the law of diminishing returns, so that there is no single average product of labor. For example, average product of labor at *A* is much higher than at *B’*, which is on the same isoquant.

The Boserup process of intensification can now be explained with this diagram. At *A* the community practices a very extensive method of

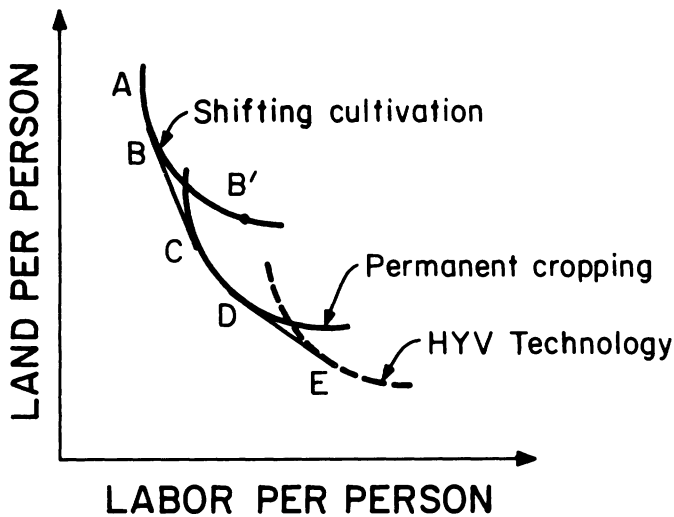


FIG. 1

shifting cultivation with plenty of forests available to cut and burn. As population grows and land becomes more scarce, the community increases its average input of labor per acre, moving down to *B* but keeping shifting cultivation its basic method of land use. It is easily established that beyond *B* the community would do well to adopt the more intensive technique of permanent cropping on part of its land, that is, move down the straight line *BC*. It is quite possible that for some reason—lack of knowledge or coordination to undertake the initial investment—the community ends up at *B'*, where the marginal product of labor is very low and “population pressure” may be said to be very high.

Three basic points are established so far: first, given the relative positions of the isoquants, the community would continue to use the extensive technique until forced to intensify by population growth, which is assumed to be the only dynamic force in the model. Second, the use of joint techniques may be very common. This means that intensification is often not the abandonment of one technique for another, but, rather, it is the increase in the ratio of cultivable land devoted to the more intensive technique: “The additional labour is likely to be used as a means to undertake a radical change of the system of cultivation in part of the area, while no change is made in other parts of the area. With further increases of population more of the area may pass to the more intensive system of land use and production.”¹⁰ Boserup also emphasizes the prevalence of the use of joint techniques in the chapter entitled “The Co-existence of Cultivation Systems.” Third, the diagram produces a more applicable notion of population

pressure based on the marginal product of labor rather than population density as is commonly assumed in empirical studies.¹¹ Indeed, it is easily seen from figure 1 that point *B'*, which has a lower population density than *D*, actually represents a higher level of population pressure. Only when both techniques are in use (along *BC*) can we be sure of a correspondence between population pressure and population density.

Robinson and Schutjer argue that Boserup's hypothesis is consistent with the technical progress interpretation of intensification. This means that we can draw the second isoquant to the left and below the first one (as they do in their fig. 2*B*) such that the two do not touch or intersect and still preserve the argument that population growth will bring about the adoption of the more intensive technique. The problem with such a view is that under the technical progress assumption permanent cropping should be always superior to shifting cultivation, and population increase is not needed to explain its adoption. Put differently, a proposition that argues that people adopt a superior technique under pressure from population is not a theory unless a mechanism that links population pressure and the adoption of that technique is specified. Robinson and Schutjer have not specified such a mechanism.

This is not to say that no relationship exists between population growth and invention or adoption of superior techniques. The models of induced innovation by Ahmad, Binswanger, and Hayami and Ruttan provide mechanisms through which population growth might affect the development of new technology.¹² On the basis of these models it can be argued that, by making land scarce, population growth induces the development of intensive techniques of land use. In her later work, Boserup too admits of a relationship between population and technical progress but without any specific model in mind: "Although demographic factors seem to have played a larger role in transmission than in invention of technology, they no doubt also provided some motivation for invention."¹³

The technical progress interpretation of intensification seems to contradict three types of observations made by Boserup and others. First, that the reduction in population pressure often resulted in deintensification of land use.¹⁴ Second, that most of the techniques under consideration were often known to the community long in advance of their adoption, and, third, that as noted above, there is an abundance of evidence of communities that practice both techniques simultaneously.¹⁵ These observations are not consistent with the technical progress interpretation of intensification.

The difficulty with Robinson and Schutjer's paper seems, in part, to stem from the familiar confusion between the number of hours worked and the number of people working. They write, "Salehi-Isfahani defines a falling average product of labor as one of the fundamental

characteristics of the intensification model. Yet if the entire intensification process is an adaptive response by the cultivators (and society) to protect an existing standard of living threatened by fixed land area and growing population, it is inadequate and ineffective if, in fact, average product does fall."¹⁶ The answer to this criticism is that product per man need not fall since more hours are worked per person. Longer working hours is indeed one of the crucial features of the Boserup model. Boserup herself is rather clear on this point: "When the growth of population in a given area of pre-industrial subsistence farming results in lower average output per man-hour in agriculture, the reaction normally to be expected would be an increase of the average number of hours worked per year so as to offset the decline in returns per man-hour."¹⁷ As figure 1 shows, both the marginal and the average product of labor are falling as we move from *A* to *B*, *C*, and *D*. Since these points imply the same (subsistence) level of output per person, hours worked per person must necessarily increase along the way.

There is yet another fundamental difference between my treatment of the Boserup model and that of Robinson and Schutjer. In their formalization they appear to make the increase in the input of labor *exogenous* (see their fig. 1, not reproduced here). This is accomplished by letting *L*, the labor input, be equal to *P*, the size of population, times an exogenously given labor-force participation rate, *l*. Thus with population increase the labor input increases exogenously, leading to more output and eventually to a change in technique. But this is very different from Boserup's model. For her the hours worked per person and, therefore, the input of labor are *endogenous*, increasing with the adoption of more intensive techniques. When the actual input of labor is endogenous, the role of population growth in the model is not on the supply side. As I argued in my paper to which reference is made by Robinson and Schutjer, the proper role for population is on the demand side, raising the food requirements of the community and hence causing intensification.¹⁸

Finally, to underline the significance of the point at issue for modern agriculture, let us examine a point made by Robinson and Schutjer regarding the nature of the high-yielding varieties (HYV) technology. They draw a production function signifying pure technical progress and claim that it might represent the high-yielding varieties.¹⁹ I believe that Boserup's analysis and the exposition of figure 1 are precisely useful in drawing our attention to a second possibility, namely, that the HYV package may well lie to the right of the current intensive techniques (see fig. 1), implying technical change rather than technical progress.²⁰ Only for those to the right of point *D* does the adoption of HYVs make any sense, and for those with lower levels of population pressure the extra labor may not be worth the extra output. Who is to decide where the isoquant actually lies? I believe a Boserupian answer would be,

"the cultivators." The labor requirements of the new technique are too complicated for someone who is not actually doing the work to be in a position to decide as well as the cultivator can whether the HYV technology dominates the existing techniques at all land-labor ratios. This way of looking at the problem has the interesting policy implication that, to increase the rate of adoption of HYVs, what we need is not more dissemination of information per se but, rather, more investment or technical progress in HYV technology, which would shift its isoquant to the left and thus make it desirable for a greater number of cultivators.

Notes

1. W. C. Robinson and W. A. Schutjer, "Agricultural Development and Demographic Change: A Generalization of the Boserup Model," *Economic Development and Cultural Change* 32 (January 1984): 355-66.

2. D. Salehi-Isfahani, "Population Growth and Adoption of Agricultural Techniques: A Model of Intensification for Traditional Agriculture," in *Proceedings of International Population Conference, Mexico City, 1977* (Liege: International Union for the Scientific Study of Population, 1977), pp. 25-46.

3. E. Boserup, *The Conditions of Agricultural Growth* (Chicago: Aldine Publishers, 1965), p. 33.

4. *Ibid.*, p. 66.

5. *Ibid.*, p. 67.

6. *Ibid.*, p. 39.

7. Robinson and Schutjer, p. 363.

8. *Ibid.*, p. 360.

9. This statement appears as a non sequitur in the light of this quote from Boserup (p. 26), which they immediately present: "We cannot apply continuous production functions of the usual type when we wish to consider the effects of demographic change in pre-industrial agriculture." I believe that what Boserup is saying is that the production set is not strictly convex, which is also consistent with the interpretation of fig. 1.

10. *Ibid.*, p. 26.

11. See, e.g., J. L. Simon, "The Positive Effect of Population Growth on Agricultural Saving in Irrigation Systems," *Review of Economics and Statistics* 57 (February 1975): 71-79.

12. S. Ahmad, "On the Theory of Induced Innovations," *Economic Journal* 76 (June 1966): 344-57; H. P. Binswanger, "A Microeconomic Approach to Induced Innovation," *Economic Journal* 84 (December 1974): 940-58; Y. Hayami and V. W. Ruttan, *Agricultural Development: An International Perspective*, 2d ed. (Baltimore: Johns Hopkins University Press, 1985).

13. E. Boserup, *Population and Technological Change: A Study in Long Term Trends* (Chicago: University of Chicago Press, 1981).

14. See Boserup, *The Conditions*, p. 62; R. H. Britnell, "Agricultural Technology and Margin of Cultivation in the Fourteenth Century," *Economic History Review* 30 (February 1977): 53-66; R. Netting, *Hill Farmers of Nigeria: Cultural Ecology of the Jos Plateau* (Seattle: University of Washington Press, 1968); D. Salehi-Isfahani, "Population Growth and Agricultural Intensification: A Model and Some Empirical Evidence from Iran" (Ph.D. diss., Harvard University, 1977).

15. Boserup, *The Conditions*; and M. B. Gleave and H. P. White, "Popu-

lation Density and Agricultural Systems in West Africa," *Environment and Land Use in Africa*, ed. M. F. Thomas and G. W. Whittington (London: Methuen, 1969), pp. 273–300.

16. Robinson and Schutjer, p. 362.

17. Boserup, *The Conditions*, p. 45.

18. A similar interpretation has been given by a number of authors including, J. F. Levi, "Population Pressure and Agricultural Change in the Land Intensive Economy," *Journal of Development Studies* 12 (October 1976): 61–78; W. A. Darity, "The Boserup Theory of Agricultural Growth: A Model for Anthropological Economists," *Journal of Development Economics* 7 (June 1980): 137–57; F. L. Pryor and S. B. Maurer, "On Induced Economic Change in Precapitalist Societies," *Journal of Development Economics* 10 (June 1982): 325–53; and D. Salehi-Isfahani, "Technology and Preferences in the Boserup Model of Agricultural Growth," Working Paper no. E86-07-01 (Blacksburg: Virginia Polytechnic Institute and State University, Department of Economics, 1986), forthcoming in *Journal of Development Economics*.

19. Robinson and Schutjer, p. 363.

20. For a review of the evidence on the nature of this technology, see V. W. Ruttan and H. P. Binswanger, "Induced Innovation and the Green Revolution," in *Induced Innovation*, ed. H. P. Binswanger and V. W. Ruttan (Baltimore: Johns Hopkins University Press, 1978), pp. 358–408.